APPENDIX 8.12A

Vulnerability Analysis

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Introduction

The proposed Central Valley Energy Center (CVEC) is a 1,060 megawatt (MW) net combined-cycle generating facility with three combustion turbine generators (CTGs) equipped with dry, low oxides of nitrogen (NO_x) combustors and steam injection power augmentation capability, three heat recovery steam generators (HRSGs) equipped with duct burners, and one condensing steam turbine generator (STG).

CVEC, under the jurisdiction of the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), is required[1] to apply Best Available Control Technology (BACT) to control emissions of pollutants that exceed specified thresholds. Selective catalytic reduction (SCR) has been chosen to limit NO_x pollutants exhausted to the atmosphere to 2.5 ppmvd at 15 percent oxygen from the CTG/HRSGs (2.0 ppmvd on an average annual basis). NO_x emissions from an auxiliary boiler will also be controlled to 9 ppmvd at 3-percent oxygen to meet BACT requirements.

The SCR equipment will include a reactor chamber, catalyst modules, ammonia storage system, ammonia vaporization and injection system, and monitoring equipment and sensors. The SCR control system uses ammonia as the reduction medium in the presence of a catalyst. Two forms of ammonia may be used in currently designed SCR systems, i.e., aqueous ammonia or anhydrous ammonia. The CVEC facility is proposing to use anhydrous ammonia. Section 8.12 of the Application for Certification (AFC) contains a detailed description of the facility location and process data. Figure 2.2-1 (Project Description) presents the facility site plan.

CVEC will store anhydrous ammonia in two stationary, pressurized storage tanks. The capacity of each tank will be approximately 12,000 gallons, but each of the tanks will be limited by regulation to storing a maximum amount of 10,200 gallons, or 58,038 lbs or ammonia. The tanks will be enclosed by a secondary containment structure capable of holding the full contents of the tanks. The floor of the containment structure will be sloped to a trench located between the two tanks. The trench, in turn, will be sloped to drain to a single sump. The sump dimensions are as follows:

- Length 15 feet
- Width 15 feet
- Depth 6.5 feet

The surface area of the sump will be 225 square feet and the volume will be approximately 10,900 gallons. The trench will be approximately 21 feet long and 1 foot wide, with a

[1] Per Rule 2201 (New and Modified Stationary Source Review Rule), which combines implementation of both the federal and California new source review (NSR) program

resultant surface area of 21 square feet .The total surface area for purposes of the OCA analysis will therefore be 246 square feet, or 22.85 square meters.

The delivery truck will connect to the pressurized tank via a 25-foot-long loading hose. The loading hose will have an inside diameter of 2 inches.

Probability of Release

Anhydrous ammonia is a gas that is maintained in a liquid state through pressurization of the handling and storage systems. Anhydrous ammonia has a boiling point of approximately minus 28.1°F. When spilled, anhydrous ammonia will vaporize, releasing ammonia vapors to the surrounding atmosphere. Accidental releases of anhydrous ammonia in industrial use situations are rare. Statistics compiled on the normalized accident rates for RMP chemicals for the years 1994-1999 from *Chemical Accident Risks in U.S. Industry-A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities, J.C. Belke, Sept 2000*, indicates that ammonia (all forms) averages 0.017 accidental releases per process per year, and 0.018 accidental releases per million pounds stored per year. Data derived from *The Center for Chemical Process Safety, 1989*, indicates the accidental release scenarios and probabilities for ammonia in general shown in Table 8.12A-1.

TABLE 8.12A-1
General Accidental Release Scenarios and Probabilities for Ammonia

Accident Scenario	Failure Probability
Onsite Truck Release	0.0000022
Loading Line Failure	0.005
Storage Tank Failure	0. 000095
Process Line Failure	0.00053
Evaporator Failure	0.00015

Off-site Consequence Analysis

Pursuant to the federal RMP and CalARP regulations, the offsite consequence analysis (OCA) is to be performed for the release scenario that involves the failure and complete discharge of the main storage tank, as well as an alternative release scenario as determined by facility staff. As such, two scenarios were modeled for this response, as follows:

- Tank failure scenario incorporating the secondary containment area (trench and sump).
- Delivery vessel loading hose failure with the hose contents being spilled to the ground surface.

For purposes of this OCA, two sets of meteorological data were used as follows:

- U.S. Environmental Protection Agency (USEPA) default meteorological data for the worst case release.

- USEPA default meteorological data for the alternative case release.
- The default meteorological data was supplemented, for the worst case scenario, by daily temperature data as required by 19 CCR 2750.2.

Computer Modeling

Table 8.12A-2 shows the meteorological data values used in the modeling scenarios.

TABLE 8.12A-2
Meteorological Data Used in Modeling

Parameter	Worst Case Meteorological	Alternate Case Meteorological
Wind Speed (m/sec)	1.5	3.0
Stability Class	F	D
Relative Humidity (%)	50	50
Ambient Temperature (°F)	105	77

A total of two modeling runs were conducted; i.e., single tank failure, and truck loading hose failure for the corresponding meteorological scenarios listed in Table 1.

OCA modeling was conducted using the SLAB model. A complete description of the SLAB model is available in *User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air-Releases, D. E. Ermak, Lawrence Livermore National Laboratory, June 1990*. The current version of SLAB contains an internal substance database including chemical specific data for ammonia. This data was used in all modeling runs without exception or modification.

Emissions of anhydrous ammonia were calculated pursuant to the guidance given in *RMP Offsite Consequence Analysis Guidance, USEPA, April 1999.*

- For the main storage tank scenario, the total amount released would be equal to the maximum amount allowed for storage; i.e., 10,200 gallons or 58,038 pounds (lbs.). The complete failure of a single pressurized tank would result in a release of both vapor and liquid fractions of anhydrous ammonia. The liquid would form an "instantaneously evaporating pool." The total release and evaporation of 58,038 lbs. of ammonia over the required 10-minute release period would result in an emission rate of 5,803.8 pounds/minute (lbs./min.).
- Emissions for the truck loading hose failure scenario are based upon a 25-foot hose length, with a 2-inch diameter. The hose would hold approximately 26 lbs. of ammonia. Using a 10-minute release period would result in emissions of ammonia from this scenario of approximately 2.6 lbs/min. This assumes instantaneous shutoff of supply from the tank truck.

Although the edge of the tank containment area is raised above ground level, the release heights used in the modeling were set at 0 feet above ground level to maintain the conservative nature of the analysis.

Toxic Effects of Ammonia

With respect to the assessment of potential impacts associated with an accidental release of ammonia, four offsite "bench mark" exposure levels are typically evaluated, as follows; (1) the lowest concentration posing a risk of lethality, 2000 ppm; (2) the Immediately Dangerous to Life and Health (IDLH) level of 300 ppm; (3) the Emergency Response Planning Guideline (ERPG) level of 200 ppm, which is also the RMP level 1 criterion used by the USEPA and California; and (4) the level considered by CEC staff to be without serious adverse effects on the public for a one-time exposure of 75 ppm [2].

The odor threshold of ammonia is about 5 ppm, and minor irritation of the nose and throat will occur at 30 to 50 ppm. Concentrations greater than 140 ppm will cause detectable effects on lung function even for short-term exposures (0.5 to 2 hours). At higher concentrations of 700 to 1,700 ppm, ammonia gas will cause severe effects; death occurs at concentrations of 2,500 to 7,000 ppm.

The specified toxic endpoint (TE) value for ammonia is 0.14 milligrams per litre (mg/L), which is approximately equal to 212 ppm. The TE value is based on a one-hour exposure or averaging time. Therefore, the modeling concentrations at all offsite receptors will be given in terms of a one-hour (or 60 minute) averaging time.

The nearest sensitive receptor is a residence located approximately 760 meters west of the tank location. Another sensitive receptor is Golden Plains School District Unified Alternate Education facility located approximately 1375 m northwest of the tank location.

Modeling Results

Table 8.12A-3 shows the distances for the two release scenarios to the USEPA/CalARP toxic endpoint of 212 ppm and the CEC significance value of 75 ppm. Figure 8.12A-1 shows the distance from the ammonia storage tank to the modeled TE (212 ppm) and CEC (75 ppm) significance values for the tank rupture and loading hose rupture scenarios. The data indicates that neither of these concentrations is experienced at any of the identified sensitive receptors. Therefore, the risk of exposure to anhydrous ammonia from a tank or hose rupture would not create a significant impact.

TABLE 8.12A-3
Modeling Results

Scenario	Distance in meters to USEPA/CalARP TE, (212 ppm)	Distance in meters to CEC Significance Value (75 ppm)	Sensitive Receptors Impacted
Tank Rupture	< 400 m	< 450 m	None
Loading Hose Rupture	(1)	< 100 m	None

(1) No concentration equaling or exceeding the TE value was modeled for this scenario.

(The model input and output files are available upon request.)

[2] Preliminary Staff Assessment, Otay Mesa Generating Project, 99-AFC-5, May 2000

Transportation-related Hazardous Materials Releases

CVEC LLC will purchase anhydrous ammonia from a local distributor, licensed to deliver anhydrous ammonia. The distributors contacted have indicated that anhydrous ammonia deliveries are made with a vehicle meeting the Department of Transportation (DOT) MC-330 or MC-331 specifications. CVEC LLC will direct all vendors delivering anhydrous ammonia to the site to use only transport vehicles that meet or exceed these DOT specifications.

Transportation Risk Assessment

Anhydrous ammonia will be transported to the project site using the DOT-compliant tanker trucks specified above. The transportation of anhydrous ammonia, and any other hazardous material, poses a risk of exposure to the surrounding population due to an accidental release caused by a traffic accident involving the delivery vehicle.

An anhydrous ammonia leak occurring during delivery or transport of the material to the storage tank could result in hazardous ambient concentrations. The impact of this accidental release would depend upon the location of the release relative to the public. The probability of release is a function of vehicle miles traveled x the probability of incident/mile. Probability is based on accident statistics. Factors such as skill of driver, meteorological and highway conditions, road type, traffic, etc influence the probability.

There are extensive regulatory programs in place in the United States and California to ensure safe handling during the transportation of hazardous materials (see the Federal Hazardous Materials Transportation Law [49 U.S.C. § 5101 et seq.], the US Department of Transportation Regulations [49 CFR Subpart H, § 172-700], and California DMV Regulations on Hazardous Cargo [CCR, Vehicle Code, §34000]). These regulations also address driver's abilities and experience and are reflected in the low incident rates.

Background on Hazardous Material Shipment

The federal Office of Hazardous Materials Safety (OHMS) reports that about 280,000,000 hazardous material shipments are made by truck per year (Hazardous Materials Shipments, OHMS Report, 1998). The hazardous materials transportation incident statistics (for 1991 to 1998) indicate a maximum of 466 serious highway incidents occurred in 1994. The OHMS defines a serious incident as causing one of the following: a fatality or major injury, closure of a major transportation artery or facility, results in the evacuation of six or more persons, or results in the release of hazardous materials. The reported number of anhydrous ammonia releases for the years 1998-2001, was 51.

Transportation Probability Analysis

Technical and scientific literature on hazardous materials transportation was reviewed for accident rates in the United States and California in performing this transportation probability analysis for the delivery of anhydrous ammonia to the CVEC project. The following references were used to prepare this hazardous materials transportation probability analysis:

Davies, P.A. and Lees, F.P. 1992. "The Assessment of Major Hazards: The Road Transport Environment for Conveyance of Hazardous Materials in Great Britain." Journal of Hazardous Materials, 32: 41-79.

Harwood, D.W., Viner, J.G., and E.R. Russell. 1993. "Procedure for Developing Truck Accident and Release Rates for Hazmat Routing." Journal of Transportation Engineering. 119(2): 189-199.

Vilchez, J.A., Sevilla, S., Montiel, H., and J. Casal. 1995. "Historical Analysis of Accidents in Chemical plants and in the Transportation of Hazardous Materials." J. Loss Prev. Process Ind. 8(2): 87-96.

National Response Center (www.nrc.uscg.mil).

Chemical Incident Reports Center, U.S. Chemical Safety Board (www.chemsafety.gov).

National Transportation Safety Board (www.ntsb.gov).

Data presented in Davies and Lees study conducted in 1992 (which uses data from the 1990 Harwood study) identifies the frequency of hazardous materials release during transportation as between 0.06 and 0.77 releases per million miles traveled. The study presented data for the 3 dominant road types in the study; urban freeway, rural freeway, and 2-lane rural road. The reported frequency of a hazardous materials release per million miles traveled was 0.06 (urban freeway), 0.14 (rural freeway), and 0.19 (2-lane rural road). Davies and Lee also estimated the probability of an incident randomly occurring in an area where a large number of people would be exposed. This analysis estimated that 8.9 percent of the incidents would cause more than 10 fatalities and 1.4 percent would cause more than 33 deaths.

Since the project site lies in a rural area, the 2-lane rural road value would provide the most conservative estimate of an incident occurring. The anhydrous ammonia tanker trucks traveling to CVEC will traverse roads designated as rural highways (I-5) and 2-lane roads (Manning Avenue). Using the data presented by Davies and Lee for the reported frequency of a hazardous material transportation related release of 0.19 releases per million miles traveled on 2-lane roads; the estimate that 8.9 percent of the incidents would cause more that 10 fatalities; and the estimated that 1.4 percent of incidents would cause more than 33 deaths, the risk of the various incidents can be calculated.

CVEC LLC estimates the annual number of anhydrous ammonia deliveries to be 37 per year. Based on the suggested delivery route (see Section 8.10.4.3), each truck will travel approximately 23 miles along Manning Avenue from I-5 to the plant. The probabilities estimated by the Davies and Lee study of a release causing death were for accidents occurring where a "large number of people would be exposed." The route from I-5 to the City of San Joaquin is through agricultural land and generally uninhabited. Therefore, most of the route does not meet the criteria of having large numbers of people present. To make the probability analysis meaningful, a distance of 2 miles through town plus a 4-mile buffer before town is used. Thus, the estimated annual miles the loaded ammonia delivery trucks will travel through a populated area is 222 miles (37 trips/year x 6 miles). The maximum risk of accidental release and potential fatality of more than 10 people can be calculated as 0.19 (frequency per million miles traveled on a 2-lane road) x 0.089 (percent of incidents that would cause more than 10 fatalities) x 222 miles traveled/year equals 3.75 per one million miles traveled per year, or 0.038 in 100,000 miles traveled. Similarly, the risk of fatality of more than 33 people is less than 0.59 in one million miles traveled (0.19 x .014 x 222).

The CEC uses a significance threshold of 1 in 100,000 for risk of 10 fatalities and a threshold of 1 in 1,000,000 for risk of 100 fatalities in other licensing cases[3]. Under these conditions, both of the risk estimates (0.037/100,000 miles and 0.59/1,000,000 miles) are less than these thresholds. Therefore, the risk of exposure to anhydrous ammonia during transport to the plant is insignificant.

[3] See Contra Costa Power Plant 00-AFC-01.